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EP 0711056 A2   WO 99/38265 A1   WO 97/05717 A1
WO 95/08888 A1   WO 95/01032 A1   US 5453997 A

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(54) Abstract Title
Determining the rate of received data in a variable rate communication system

(57) Received data is decoded at each of several possible data rates using respective pre-decoders 201, 206, 211, 216 which have a simple structure and rapidly perform decoding. The decoded data is then re-encoded 202, 207, 212, 217 and compared 203, 208, 213, 218 to the received data in order to provide a measure of the quality of the decoded data at each rate, e.g. a symbol error rate. An estimate of the data rate is made based on the quality measures and final decoding of the received data is performed by a viterbi decoder 222 operating at the estimated rate. Thus viterbi decoding is only performed at one data rate resulting in increased speed and reduced power consumption compared to the prior art (figure 1). Application is to variable-rate systems such IS-95 CDMA and IMT-2000.
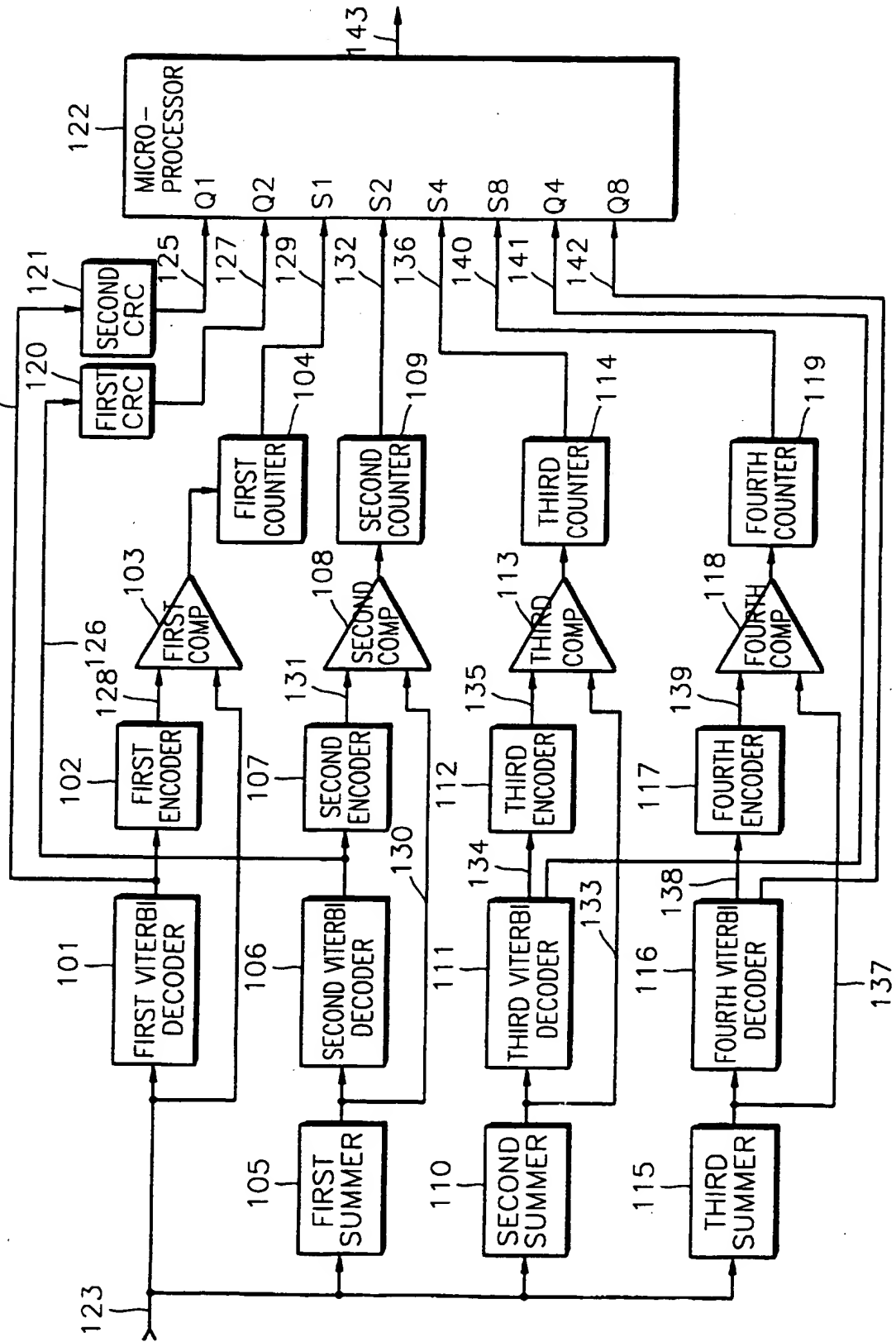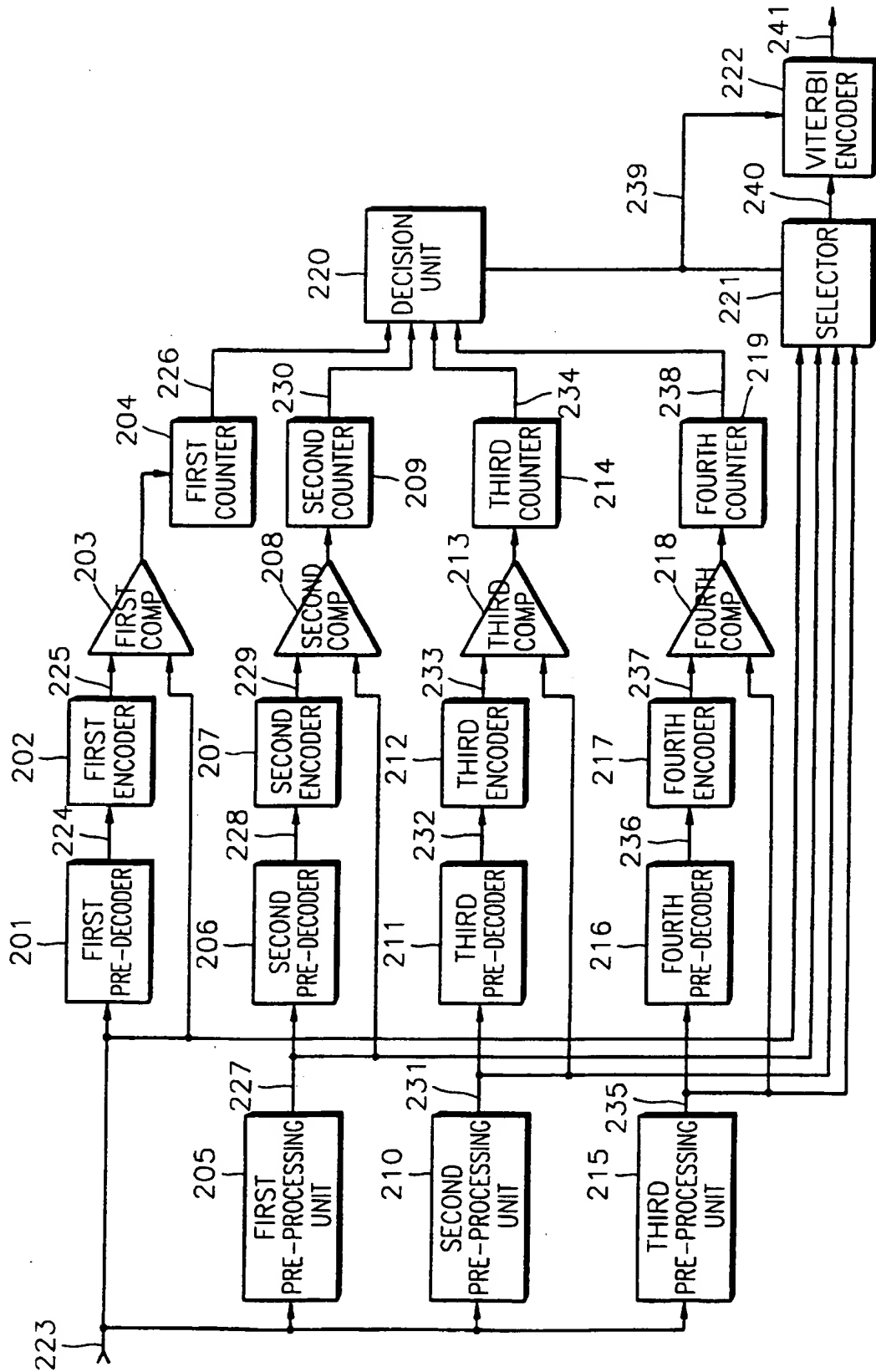
FIG. 2
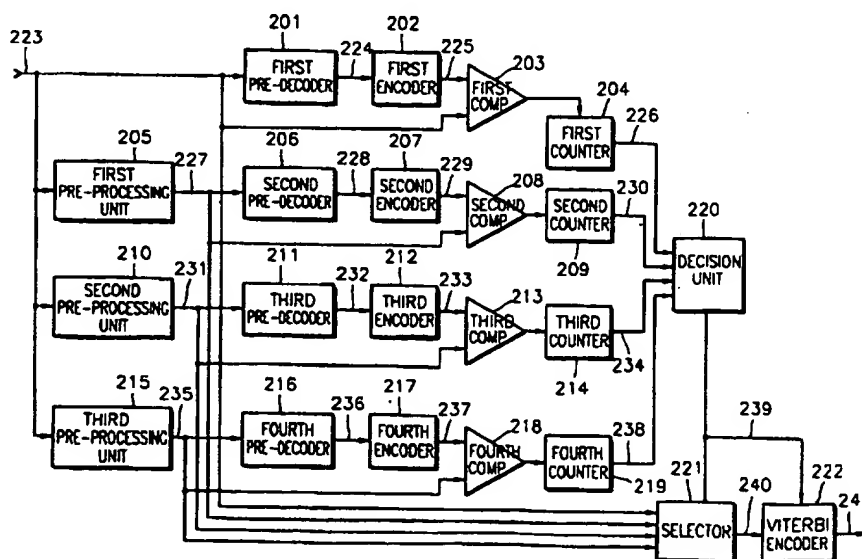
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FIG. 1 (PRIOR ART)

FIG. 2

METHOD AND APPARATUS FOR DETERMINING
RATE OF DATA TRANSMITTED AT VARIABLE RATES

5   The present invention relates to digital communications, and more particularly to a method and apparatus for determining rate of data transmitted at a variable rate in a variable-rate communications system.

10   In variable-rate communications systems such as a variable-rate voice coder, the data rate of transmitted data should be determined in order to receive and process the transmitted variable-rate data without an indication of the data rate. U.S. Patent No. 5,566,206, entitled
15 *"Method And Apparatus For Determining Data Rate of Transmitted Variable Rate Data in a Communications Receiver"*, will now be briefly described with reference to Figure 1.

20   In a conventional apparatus for determining data rate shown in Figure 1, a first Viterbi decoder 101 performs Viterbi decoding on received data under the assumption that the data is received at a full rate, a first encoder 102 re-encodes the output from the first Viterbi decoder
25 101, a first comparator (COMP) 103 compares the received data 123 to the data 128 which is obtained by re-encoding the output 124 from the Viterbi decoder 101 in the first encoder 102, and a first counter 104 outputs the number of errors 129 according to the output from the first COMP
30 103.

       A first summer 105, a second Viterbi decoder 106, a second encoder 107, a second COMP 108 and a second counter

109 perform the same operations as above at a half rate. A second summer 110, a third Viterbi decoder 111, a third encoder 112, a third COMP 113 and a third counter 114 operate as above at a 1/4 rate. A third summer 115, a

5 fourth Viterbi decoder 116, a fourth encoder 117, a fourth COMP 118 and a fourth counter 119 operate as above at a 1/8 rate. A microprocessor 122 determines the rate of the received data using error metrics 129, 132, 136 and 140 from the first, second, third and fourth counters 104,

10 109, 114 and 119, CRC results 125 and 127 from first and second cyclic redundancy code circuits (CRCs) 120 and 121, and Yamamoto Quality Metrics 141 and 142 from the third and fourth Viterbi decoders 111 and 116.

15 The conventional rate determination apparatus shown in Figure 1 adopts a post-data rate determination method using Viterbi decoders which have a complicated structure and require much time to decode data. That is, after performing Viterbi decoding at each receivable data rate,

20 the rate of the received data is determined using symbol error rates which indicate the quality of respective decoded data. Thus, power consumption increases due to the complicated structures and processing speed of the Viterbi decoders, in addition to a temporal loss.

25

In another data rate determination apparatus disclosed in U.S. Patent No. 5,627,845, entitled "*Variable Rate Communication Method and a Variable Rate Communication System,*" the rate of a received data is estimated using

30 repetition characteristics of the received data. Also, in U.S. Patent No. 5,689,511, entitled "*Data Receiver For Receiving Code Signals Having a Variable Data Rate,*" the number of repetitions is determined by calculating an

auto-correlation function of a received data frame, and the rate of the received data is then estimated.

It is an aim of at least a preferred embodiment of the
5 present invention to provide a pre-data rate determination method in which pre-decoding is performed at each receivable data rate and the rate of received data is determined using quality information (symbol error rate) of the pre-decoded data.
10

It is another aim of a preferred embodiment of the present invention to provide a data rate determination apparatus in a variable-rate communications system, which determines the rate of received data using pre-decoders
15 adopting a simple structure and a rapid decoding speed, in a case where information about the data rate is not known upon receiving of the data.

According to a first aspect of the present invention
20 there is provided a method for determining the rate of received data in a variable-rate communications system, the method comprising the steps of: (a) pre-decoding the received data at receivable data rates and detecting quality information of the data pre-decoded at the
25 respective data rates; and (b) estimating the rate of the received data based on the quality information of the data pre-decoded at the respective data rates.

Preferably, a generating function for the pre-decoding
30 in the step (a) is the inverse function of a generating function used for encoding.

Preferably, the quality information is a symbol error rate.

Preferably, the method further comprises the step of (c) Viterbi decoding only the data which corresponds to the estimated data rate.

Also according to the present invention there is provided a method for determining the rate of data received by a receiver in a variable-rate communications system, the method comprising the steps of: pre-decoding the received data at a first data rate and re-encoding the result to output a first quality indication; comparing the received data to the first quality indication, and counting the number of errors according to the comparison result to output an error metric with respect to the first data rate; pre-decoding the received data at a second data rate and re-encoding the result to output a second quality indication; comparing the received data to the second quality indication, and counting the number of errors according to the comparison result to output an error metric with respect to the second data rate; and estimating the rate of the received data by the error metrics with respect to the first and second data rates.

Preferably, the method further comprises the step of (f) selecting the data corresponding to the estimated data rate and Viterbi decoding the selected data.

Preferably, a generating function for pre-decoding has the inverse function of a generating function for encoding.

Preferably, the method further comprises the steps of: pre-decoding the received data at a third data rate and re-encoding the result to output a third quality indication; and comparing the received data to the third quality indication, and counting the number of errors according to the comparison result to output an error metric with respect to the third data rate, wherein the error metric with respect to the third data rate is also compared in the estimation of the data rate in the step (e).

According to a second aspect of the present invention there is provided an apparatus for determining the rate of received data in a variable-rate communications system, the apparatus comprising: a first means for pre-decoding the received data at receivable data rates and providing quality information of the data pre-decoded at the respective data rates; and a second means for estimating the rate of the received data based on the quality information of the data pre-decoded at the respective data rates.

Preferably, the quality information is a symbol error rate.

Preferably, the apparatus further comprises a Viterbi decoder for Viterbi decoding only the data which corresponds to the estimated data rate.

Also according to the present invention there is provided an apparatus for determining the rate of data received by a receiver in a variable-rate communications system, the apparatus comprising: a first pre-decoder for

pre-decoding the received data having a first data rate;a first encoder for re-encoding the output from the first pre-decoder;a first comparator for comparing the data having the first data rate to the output from the first

5   encoder;a first counter for counting the comparison result of the first comparator;a second pre-decoder for pre-decoding the received data having a second data rate;a second encoder for re-encoding the output from the second pre-decoder; a second comparator for comparing the data

10   having the second data rate to the output from the second encoder; a second counter for counting the comparison result of the second comparator; and a decision unit for deciding the rate of the received data using the outputs from the first and second counters and generating

15   selection information.

Preferably, the apparatus further comprises a first pre-processing unit in front of the second pre-decoder.

20   Preferably, the first pre-processing unit is constructed of a summer, a combiner or a selector.

Preferably, the apparatus further comprises: a third pre-decoder for pre-decoding the data having a third data

25   rate; a third encoder for re-encoding the output from the third pre-decoder; a third comparator for comparing the data having the third data rate to the output from the third encoder; and a third counter for counting the comparison result of the third comparator; wherein the

30   output from the third counter is also applied to the decision unit.

Preferably. the apparatus further comprises a first pre-processing unit in front of the second pre-decoder.

Preferably, the apparatus further comprises a second pre-processing unit in front of the third pre-decoder.

Preferably, the first and second pre-processing units are constructed of a summer, a combiner or a selector.

Preferably, the apparatus further comprises: a fourth pre-decoder for pre-decoding the data having a fourth data rate; a fourth encoder for re-encoding the output from the fourth pre-decoder; a fourth comparator for comparing the data having the fourth data rate to the output from the fourth encoder; and a fourth counter for counting the comparison result of the fourth comparator; wherein the output from the fourth counter is also applied to the decision unit.

Preferably, generating functions used in the first through fourth pre-decoders have the inverse function of a generating function for encoding.

Preferably, the apparatus further comprises a first pre-processing unit in front of the second pre-decoder.

Preferably, the apparatus further comprises a second pre-processing unit in front of the third pre-decoder.

Preferably, the apparatus further comprises a third pre-processing unit in front of the fourth pre-decoder.

Preferably, the first, second and third pre-processing units are constructed of a summer, a combiner or a selector.

5   Preferably, the apparatus further comprises: a selector for selecting one of the outputs from the first, second and third pre-processing units according to the selection information; and a Viterbi decoder for Viterbi decoding only the output from a pre-processing unit,

10   selected by the selector.

For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to

15   the accompanying diagrammatic drawings in which:

Figure 1 is a block diagram of a conventional data rate determination apparatus; and

20   Figure 2 is a block diagram of a data rate determination apparatus according to a preferred embodiment of the present invention.

Referring to Figure 2, in a data rate determination

25   apparatus according to a preferred embodiment of the present invention, as in an IS (Interim Standard)-95 system, the data rate of a transmitted and received data is assumed to be one of four rates; full rate, half rate, 1/4 rate and 1/8 rate.

30

The data rate determination comprises a first pre-decoder 201, a first encoder 202, a first comparator (COMP) 203 and a first counter 204, which are for pre-

decoding received data 223 by assuming the received data rate to be a first data rate, for example, the full rate, and obtaining quality information of the decoded data; a first pre-processing unit 205, a second pre-decoder 206, a

5   second encoder 207, a second COMP 208 and a second counter 209, which are for pre-decoding the received data 223 by assuming the received data rate to be a second data rate, for example, the half rate, and obtaining quality information of the decoded data; a second pre-processing

10   unit 210, a third pre-decoder 211, a third encoder 212, a third COMP 213 and a third counter 214, which are for pre-decoding the received data 223 by assuming the received data rate to be a third data rate, for example, the 1/4 rate, and obtaining quality information of the decoded

15   data; a third pre-processing unit 215, a fourth pre-decoder 216, a fourth encoder 217, a fourth COMP 218 and a fourth counter 219, which are for pre-decoding the received data 223 by assuming the received data rate to be a fourth data rate, for example, the 1/8 rate, and

20   obtaining quality information of the decoded data; a decision unit 220 for deciding the rate of the received data using quality information 226, 230, 234 and 238; a selector 221 for selecting one of data 223, 227, 231 and 235 pre-processed at receivable data rates, using

25   information 239 corresponding to the data rate determined by the decision unit 220; and a Viterbi decoder 222 for Viterbi-decoding data 240 corresponding to the selected data rate. The first through fourth pre-decoders 201, 206, 211 and 216, the first through fourth encoders 202,

30   207, 212 and 217, the first through fourth comparators 203, 208, 213 and 218, and the first through fourth counters 204, 209, 214 and 219 can be collectively referred to as a first means for pre-decoding the received

data at receivable data rates and providing quality information of the data pre-decoded at respective data rates and the decision unit 220 can be referred to as a second means for estimating the rate of the received data
5   based on the quality information of the data pre-decoded at the respective data rates.

In the operation of the data rate determination apparatus shown in Figure 2, the received data 223 which
10   is demodulated symbol data, is provided to the first pre-decoder 201 and the first through third pre-processing units 205, 210 and 215. The first through third pre-processing units 204, 210 and 215 may be constructed of a summer or a combiner in the case where the data is
15   repeatedly transmitted according to respective data rates, or of a selector in the case where only a selected part of every symbol is transmitted according to the data rate.

That is, the first pre-processing unit 205 sums the
20   received data 223 every two-symbol unit or extracts half of the symbol, and outputs the data 227 pre-processed at a half rate. The second pre-processing unit 210 sums the received data 223 every four-symbol unit or extracts one fourth of the symbol, and outputs the data 231 pre-
25   processed at a 1/4 rate. The third pre-processing unit 215 sums the received data 223 every eight-symbol unit or extracts one eighth of the symbol, and outputs the data 235 pre-processed at a 1/8 rate.

30   The first through fourth pre-decoders 201, 206, 211 and 216, which constitute the features of the present invention, are a kind of convolution encoder which utilizes the inverse function of a generating function of

a convolution encoder in a transmitter, as a generating function.

Assuming that the information sequence to be transmitted is I(x), the generating function is G(x) and a code sequence encoded by a convolution encoder is C(x), the following mathematical formula (1) is formed.

$$C(x) = I(x) \cdot G(x) \ldots (1)$$

The transmitter transmits C(x), and a receiver receives C(x) in addition to noise incorporated into C(x). Assuming that the received data is R(x) and error generated due to noise is E(x), the received data R(x) can be expressed by the mathematical formula (2).

$$R(x) = C(x) + E(x) \ldots (2)$$

When the first through fourth pre-decoders 201, 206, 211 and 216 are constructed as a convolution encoder which utilizes the inverse function of G(x) as a generating function, and the received data R(x) is decoded by the pre-decoders 201, 206, 211 and 216, the following mathematical formula (3) is formed.

$$R(x) \cdot G^{-1} = [C(x) + E(x)] \cdot G^{-1}(x)$$
$$= C(x) \cdot G^{-1}(x) + E(x) \cdot G^{-1}(x) \ldots (3)$$
$$= I(x) + E(x) \cdot G^{-1}(x)$$

wherein $C(x) \cdot G^{-1}(x) = I(x)$.

In the formula (3), if there is no error present in the received data, which means E(x)=0, the following mathematical formula (4) is formed.

5

$$R(x) \bullet G^{-1}(x) = I(x) + E(x) \bullet G^{-1}(x) \quad \ldots (4)$$
$$= I(x)$$

Therefore, it can be understood that the decoding can be completed by the pre-decoders. That is, the first pre-
10   decoder 201 decodes the received data 223, and the first encoder 202 re-encodes the decoded data from the first pre-decoder 201. The first comparator 203 compares the received data 223 to data 225 which is obtained by re-encoding the output 224 from the first pre-decoder 201 in
15   the first encoder 202, and the first counter 204 counts the number or errors according to the comparison result of the first comparator 203 and outputs a symbol error rate (which can be referred to as an error metric or quality information) 226 with respect to the first data rate to
20   the decision unit 220. The re-encoded data 225, 229, 233 and 237 from the first through fourth encoders 202, 207, 212 and 217 can be viewed as first through fourth quality indicator.

25   The second pre-decoder 206 decodes the data 227 pre-processed at a half rate and the second encoder 207 re-encodes the decoded data from the second pre-decoder 206. The second comparator 208 compares the data 227 pre-processed at a half rate to the data 229 which is obtained
30   by re-encoding the output 228 from the second pre-decoder 206 in the second encoder 207, and the second counter 209

counts the number of errors according to the comparison result of the second comparator 208 and outputs a symbol error rate 230 with respect to the second data rate to the decision unit 220.

The third pre-decoder 211 decodes the data 231 pre-processed at a 1/4 rate and the third encoder 212 re-encodes the decoded data from the third pre-decoder 211. The third comparator 213 compares the data 231 pre-processed at a 1/4 rate to the data 233 which is obtained by re-encoding the output 232 from the third pre-decoder 211 in the third encoder 212, and the third counter 214 counts the number of errors according to the comparison result of the third comparator 213 and outputs a symbol error rate 234 with respect to the third data rate to the decision unit 220.

The fourth pre-decoder 216 decodes the data 235 pre-processed at a 1/8 rate and the fourth encoder 217 re-encodes the decoded data from the fourth pre-decoder 216. The fourth comparator 218 compares the data 235 pre-processed at a 1/8 rate to the data 237 which is obtained by re-encoding the output 236 from the fourth pre-decoder 216 in the fourth encoder 217, and the fourth counter 219 counts the number of errors according to the comparison result of the fourth comparator 218 and outputs a symbol error rate 238 with respect to the fourth data rate to the decision unit 220.

The decision unit 220 decides the data rate having the least symbol error rate among the symbol error rates 226, 230, 234 and 238, as a data rate of the received data, and provides selection information 239 with respect to the

determined data rate to the selector 221 and the Viterbi decoder 222 in sequence. The selector 221 selects one of the data 223, 227, 231 and 235 pre-processed at receivable data rates such as a full, half, 1/4 and 1/8 rates,

5 according to the selection information 239 from the decision unit 220. The Viterbi decoder 222 performs Viterbi decoding only on data 240 which corresponds to the data rate selected by the selector 221, using the selection information 239, and outputs decoded data 241.

10

In the data rate determination method and apparatus therefor according to the present invention, received data is pre-decoded at assumed receivable data rates. However, the received data may incorporate considerable errors

15 because the assumed data rates can be different from the actual data rate. Thus, symbol error rates are calculated using the outputs from the pre-decoders to obtain the quality information of the data decoded at different data rates, and the rate of the received data can be determined

20 using the symbol error rates.

Also, even when errors are present in the received data, the symbol error rates of the data decoded by the pre-decoders differ according to the assumed receivable

25 data rates, so that the rate of the received data can be determined using the symbol error rates.

In the above embodiment, the symbol error rates of the data decoded by the pre-decoders are used as quality

30 information. In addition, the CRC results, as mentioned with reference to Figure 1, can be used. The present invention can be applied to any apparatus which determines

a variable rate of received data using quality information obtained from data decoded by pre-decoders.

5   The method and apparatus for determining the rate of data transmitted at a variable data rate according to the present invention can be applied to determine the rate of the received data in a receiver of a variable-rate communications system such as an IS-95 CDMA (Code Division Multiple Access) system and an IMT (International Mobile
10   Telecommunications)-2000 system.

       As described above, in the present invention, the rate of the received data can be estimated using pre-decoders which have a simple structure and a rapid decoding speed,
15   compared to the Viterbi decoders. Then, Viterbi decoding is performed only on data which corresponds to the estimated data rate, so that the decoding speed of the received data and the decision speed of the data rate increase, thereby lowering power consumption.
20

       The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this
25   specification, and the contents of all such papers and documents are incorporated herein by reference.

       All of the features disclosed in this specification (including any accompanying claims, abstract and
30   drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extend to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

CLAIMS

1. A method for determining the rate of received data in a variable-rate communications system, the method comprising the steps of:

(a) pre-decoding the received data at receivable data rates and detecting quality information of the data pre-decoded at the respective data rates; and

(b) estimating the rate of the received data based on the quality information of the data pre-decoded at the respective data rates.

2. The method of claim 1, wherein a generating function for the pre-decoding in the step (a) is the inverse function of a generating function used for encoding.

3. The method of claim 1 or 2, wherein the quality information is a symbol error rate.

4. The method of claim 1, 2 or 3 further comprising the step of (c) Viterbi decoding only the data which corresponds to the estimated data rate.

5. A method for determining the rate of data received by a receiver in a variable-rate communications system, the method comprising the steps of:

(a) pre-decoding the received data at a first data rate and re-encoding the result to output a first quality indication;

(b) comparing the received data to the first quality indication, and counting the number of errors according to the comparison result to output an error metric with respect to the first data rate;

(c) pre-decoding the received data at a second data rate and re-encoding the result to output a second quality indication;

(d) comparing the received data to the second quality indication, and counting the number of errors according to the comparison result to output an error metric with respect to the second data rate; and

(e) estimating the rate of the received data by the error metrics with respect to the first and second data rates.

6. The method of claim 5, further comprising the step of (f) selecting the data corresponding to the estimated data rate and Viterbi decoding the selected data.

7. The method of claim 5 or 6, wherein a generating function for pre-decoding has the inverse function of a generating function for encoding.

8. The method of claim 5, 6 or 7 further comprising the steps of:

(f) pre-decoding the received data at a third data rate and re-encoding the result to output a third quality indication; and

(g) comparing the received data to the third quality indication, and counting the number of errors according to the comparison result to output an error metric with respect to the third data rate,

5

wherein the error metric with respect to the third data rate is also compared in the estimation of the data rate in the step (e).

10   9. The method of claim 8, further comprising the steps of:

(h) pre-decoding the received data at a fourth data rate and re-encoding the result to output a fourth quality 15   indication; and

(g) comparing the received data to the fourth quality indication, and counting the number of errors according to the comparison result to output an error metric with 20   respect to the fourth data rate,

wherein the error metric with respect to the fourth data rate is also compared in the estimation of the data rate in the step (e).

25

10. An apparatus for determining the rate of received data in a variable-rate communications system, the apparatus comprising:

30   a first means for pre-decoding the received data at receivable data rates and providing quality information of the data pre-decoded at the respective data rates; and

a second means for estimating the rate of the received data based on the quality information of the data pre-decoded at the respective data rates.

11. The apparatus of claim 10, wherein the quality information is a symbol error rate.

12. The apparatus of claim 10 or 11, further comprising a Viterbi decoder for Viterbi decoding only the data which corresponds to the estimated data rate.

13. An apparatus for determining the rate of data received by a receiver in a variable-rate communications system, the apparatus comprising:

a first pre-decoder for pre-decoding the received data having a first data rate;

a first encoder for re-encoding the output from the first pre-decoder;

a first comparator for comparing the data having the first data rate to the output from the first encoder;

a first counter for counting the comparison result of the first comparator;

a second pre-decoder for pre-decoding the received data having a second data rate;

a second encoder for re-encoding the output from the second pre-decoder;

a second comparator for comparing the data having the second data rate to the output from the second encoder;

a second counter for counting the comparison result of

5   the second comparator; and

a decision unit for deciding the rate of the received data using the outputs from the first and second counters and generating selection information.

10

14. The apparatus of claim 13, further comprising a first pre-processing unit in front of the second pre-decoder.

15. The apparatus of claim 14, wherein the first pre-

15   processing unit is constructed of a summer, a combiner or a selector.

16. The apparatus of claim 13, 14 or 15 further comprising:

20

a third pre-decoder for pre-decoding the data having a third data rate;

a third encoder for re-encoding the output from the

25   third pre-decoder;

a third comparator for comparing the data having the third data rate to the output from the third encoder; and

30   a third counter for counting the comparison result of the third comparator;

wherein the output from the third counter is also applied to the decision unit.

17. The apparatus of claim 16, further comprising a first pre-processing unit in front of the second pre-decoder.

18. The apparatus of claim 17, further comprising a second pre-processing unit in front of the third pre-decoder.

19. The apparatus of claim 18, wherein the first and second pre-processing units are constructed of a summer, a combiner or a selector.

20. The apparatus of any of claims 16 to 19, further comprising:

a fourth pre-decoder for pre-decoding the data having a fourth data rate;

a fourth encoder for re-encoding the output from the fourth pre-decoder;

a fourth comparator for comparing the data having the fourth data rate to the output from the fourth encoder; and

a fourth counter for counting the comparison result of the fourth comparator;

wherein the output from the fourth counter is also applied to the decision unit.

21. The apparatus of claim 20, wherein generating functions used in the first through fourth pre-decoders have the inverse function of a generating function for encoding.

22. The apparatus of claim 20, further comprising a first pre-processing unit in front of the second pre-decoder.

23. The apparatus of claim 22, further comprising a second pre-processing unit in front of the third pre-decoder.

24. The apparatus of claim 23, further comprising a third pre-processing unit in front of the fourth pre-decoder.

25. The apparatus of claim 24, wherein the first, second and third pre-processing units are constructed of a summer, a combiner or a selector.

26. The apparatus of claim 24 or 25, further comprising:

a selector for selecting one of the outputs from the first, second and third pre-processing units according to the selection information; and

a Viterbi decoder for Viterbi decoding only the output from a pre-processing unit, selected by the selector.

27. A method for determining the rate of received data, substantially as hereinbefore described with reference to Figure 2 of the accompanying drawings.

28. An apparatus for determining the rate of received data, substantially as hereinbefore described with reference to Figure 2 of the accompanying drawings.

Application No:	GB 9920360.6	Examiner:	Matthew Nelson
Claims searched:	1-28	Date of search:	22 February 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): H4P (PEP, PF, PRV)

Int Cl (Ed.7): H03M 13/23, 13/41; H04J 3/22; H04L 1/00, 25/02

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	EP 0711056 A2	(NEC CORP.) See the abstract	
A, P	WO 99/38265 A1	(DSPC ISRAEL) See the abstract, figure 11 and p. 32, lines 14-18	
A	WO 97/05717 A1	(MOTOROLA) See the abstract and p. 10, lines 25-30	
A	WO 95/08888 A1	(QUALCOMM) See abstract	
A	WO 95/01032 A1	(QUALCOMM) See figure 2 and p. 7, lines 5-8	
X	US 5453997	(RONEY) See whole document	1-4 and 10-12

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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